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ORIGINAL ARTICLE

The Prevalence of Amblyopia in 7-year-old Schoolchildren in Iran

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ABSTRACT

Purpose: To determine the prevalence of amblyopia in schoolchildren aged 7 years in Iran, its relation with refractive errors, and its determinants.

Methods: In this cross-sectional study, cluster sampling was done from elementary school students in 7 cities in Iran. In all schools, an optometrist conducted all tests, including measurement of uncorrected and corrected visual acuity, cycloplegic refraction, and cover test. In this study, amblyopia was defined as best corrected visual acuity 20/30 or less or a 2-line interocular optotype acuity difference with no pathology.

Results: Of the 4157 students selected for the study, 3675 participated and final analyses were done with data from 3547 children. The prevalence of amblyopia was 1.88% (95% CI: 1.24–2.52) ($n = 63$). The prevalence was 1.91% (95% CI: 0.85–2.97) in boys and 1.85% (95% CI: 1.12–2.58) in girls ($p = 0.92$). Among these cases, 60.30% ($n = 38$) were unilateral. Also, 61.9% were strabismic, 27.0% were anisometropic, 9.5% were isometropic, and one case (1.6%) was due to congenital cataracts. Amblyopic individuals were more hypermetropic and the mean cylinder error was significantly higher.

Conclusion: Necessary attention should be paid to amblyopia, although its prevalence in Iran is mid-range when compared with other countries. Amblyopia is more common in hyperopic and astigmatic individuals and therefore it is important to pay more attention to this refractive error during childhood. Since strabismus is the most common cause of amblyopia in Iran, children need to be checked for strabismus before the age of 5 years.

Keywords: Amblyopia, cross-sectional-study, Iran, middle-east, prevalence

INTRODUCTION

Amblyopia is the second leading cause of bilateral visual impairment in children after refractive errors, and has been reported as the leading cause of unilateral visual impairment in pediatric patients.[1–4] Literature indicates that amblyopia is a cause of visual impairment in the elderly as well[5,6] Loss of binocular depth perception in amblyopia leads to negative impacts in terms of occupation and career choices, mental health, and even social behaviors of affected patients.[7] Today we know that major causes of amblyopia in children include severe refractive errors, anisometropia, and strabismus in Iran and worldwide.[8–14] Even though the average amblyopia prevalence is about 2.0%,[8,15–20] epidemiologic studies conducted around the world indicate that it is a common concern in childhood and thus, vision screening programs are carried out for timely detection and treatment of the condition in preschool-aged children.

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Iran is the second most populated country in the Middle East and literature contains a number of amblyopia studies from this country.[9,21,22] On average, the reported prevalence in Iranian school children is 2%. In this study, preschool-aged children aged 4–6 years and primary grade one students aged 7 years were screened. In this program, uncorrected visual acuity was evaluated to identify visual problems by a teacher or health supervisor.

The National Vision Screening Program has been conducted for over 15 years in Iran in order to identify cases in a timely manner.[23] Nonetheless, recent reports fail to show any considerable change in the prevalence of amblyopia. Differences in diagnostic methods, definitions of amblyopia, sampling methods, and sample sizes, as well as racial differences, limit our ability to properly judge the current status of amblyopia in Iran. Some studies claim reporting amblyopia prevalence in Iran while sampling has only been done from a single city. For these reasons, we designed a study for an accurate estimate of the status of amblyopia throughout Iran; here we present a part of this study.

FIGURE 1. Map of Iran with geographic locations of cities selected for this study.

MATERIALS AND METHODS

Sampling

In a cross-sectional study in 2013, sampling was done from first graders in 7 cities in different geographic regions in Iran using a multistage random cluster sampling method. In Iran, children enter primary school at the age of 7, so all children in our study were aged 7 years.

The map of Iran is presented in Figure 1 to show the distribution of the selected cities, which have different geographic profiles. In each city (cluster), an equal number of boys' and girls' elementary schools were selected completely by random. All first graders in these schools were considered for sampling and consent forms were provided for their parents to sign. On the study day, only children with signed consent forms were enrolled. First, we collected data such as demographics and parents' occupation and education from their records. Then the child proceeded to have exams.

Examinations

First, non-cycloplegic autorefraction was done by a skilled technician using the Topcon RM8800 (Topcon Corporation, Tokyo, Japan). Printed results were appended to the chart and the child proceeded to the next stage. For children with glasses, visual acuity was tested monocular and binocular with spectacle correction using the tumbling E optotype Snellen chart at 6 meters. Then their eyeglasses were tested with the Topcon LM800 lensometer (Topcon Corporation, Tokyo, Japan) and recorded along with the prescription date. Next, all children had their uncorrected visual acuity tested using the tumbling E optotype Snellen chart at 6 meters. Autorefraction results were then refined through retinoscopy with the HEINE BETA 200 (HEINE Optotechnik, Germany) and the MSD trial lenses (MSD Meniscus Trial Lenses, Italy). Subjective testing was done when uncorrected visual acuity was worse than 20/25, and results were recorded after best correction.

Near and far cover tests were performed at 40 cm and 6 m, respectively. If distant uncorrected visual acuity was less than the aforementioned l, cover test with best correction was performed. First, unilateral cover test followed by the alternative cover test was performed to detect tropia. Tropia was registered as esotropia (inward turning of the eye), exotropia (outward turning of the eye), or vertical (upward or downward turning of the eye). Unilateral decreased visual acuity accompanied by strabismus on the same side indicated strabismic amblyopia. Non-central fixation along with decreased visual acuity and mild esotropia suggested microtropia.

Finally, cycloplegic refraction was tested with the autorefractometer and retinoscopy 35 minutes after instilling cyclopentolate 1% eye drops twice in each eye with a 5-minute interval.

Definitions

In line with other studies, our definition of amblyopia was a best corrected visual acuity equal to or worse

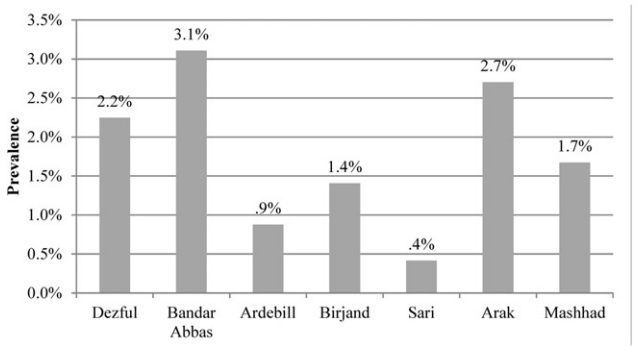

FIGURE 2. Prevalence of amblyopia in Iran by city.

than 20/30, or an interocular difference of two or more lines of optotype acuity in the absence of any pathology.[21,22] Also, definitions for refractive errors were based on spherical equivalent. Spherical equivalent values ≤ -0.50 diopter (D) were defined as myopia and spherical equivalent $\geq +2.0$ D considered as hyperopia. Astigmatism was defined as a cylinder error ≥ 0.75 D.

Statistical Analysis

We summarized the prevalence of amblyopia in percentages and their 95% confidence intervals (CI). The effect of cluster sampling was taken into account in calculating standard errors. Results were standardized based on the total number of students in the study school year. Logistic regression tests were used to examine the relation between amblyopia and possible risk factors, and the *t*-test was used to compare amblyopic and non-amblyopic cases in terms of mean spherical equivalent errors and cylinder error.

Ethical Issues

The Ethics Committee of Arak University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration. All participants signed a written informed consent.

RESULTS

Of the 4157 schoolchildren selected for this study, 3675 (88.4%) participated in the study. Final analyses were done with data from 3547 (85.3%) children because 97 did not have correction visual acuity tests and 26 lacked cycloplegic refraction data; 47.8% of the participants ($n = 1695$) were female.

Amblyopia was diagnosed in 63 children. The prevalence of amblyopia was 1.88% (95% CI 1.24–2.52). The prevalence rate was 1.91% (95% CI 0.85–2.97) in boys and 1.85% (95% CI 1.12–2.58) in girls; we found no significant association between sex and the prevalence of amblyopia ($p = 0.921$, OR = 0.96, 95% CI 0.48–1.95). Figure 2 shows the prevalence of amblyopia in the 7 cities studied. Bandar Abbas had the highest and Sari had the lowest prevalence rate; nonetheless, the chi-square test showed no significant difference among different cities ($p = 0.0645$). The prevalence rates of unilateral and bilateral amblyopia were 1.36% (95% CI 0.81–1.92) and 0.52% (95% 0.26–0.77), respectively; 60.30% ($n = 38$) of cases were unilateral. Among amblyopic eyes, the corrected visual acuity was better than 20/40 in 73.9% (mild), 20/80 to 20/40 in 20.5%, and worse than 20/80 in 5.7%. The type of amblyopia was strabismic in 51.3% of cases, anisometropic in 27.0%, isometropic in 9.5% of cases, combined (strabismus and anisometropia) in 11.1%, and in one case (1.6%), amblyopia was due to congenital cataract.

Table 1 contains the mean and 95% CI of spherical and cylinder refractive errors, as well as the uncorrected and corrected visual acuity in the two groups of amblyopic and non-amblyopic cases. As demonstrated, amblyopic cases were more hyperopic and mean cylinder error was significantly higher among them (Table 1), and they gained an average of 2.6 lines of visual acuity with correction (Table 2). Table 2 compares lines of vision gained with correction in amblyopic and non-amblyopic cases.

DISCUSSION

In the present study, we described the prevalence of amblyopia in first graders as a representative of children aged 7 years in Iran. Compared to other studies, results are more generalizable owing to sampling from the entire country using a consistent protocol. The prevalence of amblyopia in Iran was 1.88% and ranged from 0.4% to 3.1% in different cities.

Results of previous amblyopia studies in Iran are summarized in Table 3 along with results of some other studies. Compared to results in Iran, amblyopia prevalence seems to be high in some cities in Iran. Since the National Vision Screening Program for children aged 4–6 years has been conducted for over 15 years in Iran, we expected to see a low prevalence and have most cases identified and treated before entering school. Results of studies executed after year 2000 are presented in Table 3. Amblyopia prevalence rates show a great global variation starting with a minimum of 0.4% in Nepal up to 4.4% in India. In most other studies, except Turkey and India, the prevalence rates are below 2%, while the prevalence is close to 3% in some areas in Iran. This indicates that the prevalence of amblyopia is higher compared with

TABLE 1. Comparison of amblyopic and non-amblyopic cases in terms of mean spherical error, cylinder error, uncorrected visual acuity (UCVA), and best corrected visual acuity (BCVA).

	Non-amblyopic Mean (95% CI)	Amblyopic Mean (95% CI)	*p* Value
Sphere (diopter)	1.34 (1.25 to 1.44)	2.5 (1.77 to 3.23)	0.003
Cylinder (diopter)	−0.4 (−0.43 to −0.37)	−2.2 (−2.57 to −1.84)	<0.001
UCVA (LogMar)	0.01 (0.01 to 0.01)	0.67 (0.45 to 0.89)	<0.002
BCVA (LogMar)	0	0.35 (0.2 to 0.5)	<0.003

TABLE 2. Comparison between amblyopic and non-amblyopic cases in terms of lines of visual acuity gained with correction.

Lines gained	Non-amblyopic	Amblyopic	Total
1	98.1%	54.1%	97.6%
2	1.3%	24.7%	1.6%
3	0.3%	16.5%	0.5%
4	0.2%	4.7%	0.2%
5	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%

TABLE 3. Summary of previous studies on the prevalence of amblyopia.

Country	Sample size	Age (years)	Prevalence of amblyopia
Current study	3547	7	1.88%
Saudi Arabia[24]	2246	6–15	1.4%
Iran–Mashhad[9]	2510	13.2 ± 3.2	1.9%
Turkey[25]	21,062	6–14	2.6%
China[10]	3112	7.1 ± 0.4	1.0%
India[26]	6447	10–15	4.4%
Australia[12]	1765	6.7	1.8%
China[2]	3469	6–15	1.88%
Nepal[27]	446	9.26 + 2.49	0.43%
Iran[21]	2638	12.5	2.29%
Iran[22]	2020	11.2 + 2.4	2.3%

other countries in the region. A look to the studies conducted before year 2000 shows a descending trend in the prevalence of amblyopia. For example, the prevalence of amblyopia has been reported more than 4% and even 5% in some studies from Iran. Moreover, previous studies from Iran have reported amblyopia in more than 2% of the students.

One explanation for this decrease is the implementation of screening programs in most parts of the world. The variation seen among different studies is mostly due to the various cutoffs used in the definition of amblyopia. The variation seen in Iran, however, is not for this reason because the ophthalmic technicians and definitions were all the same for all studied cities. Possible explanations include variations in the efficiency of screening programs in different cities and variations in racial and geographic influences on the prevalence of myopia. Of particular interest is that the highest prevalence was seen in the most southern city and the lowest was seen in the most northern city in Iran; this observation strengthens the hypothesis that race and geographic factors may have an impact.

Different economic situations among different ethnic groups in different geographical locations, and different dietary patterns and lifestyles could be the important reasons for the difference in the prevalence of amblyopia in different geographical locations. Some biometric components of the eye are different in various ethnic populations, which may result in the difference in refractive errors. Therefore, differences in the refractive errors can also contribute to the differences in the prevalence of amblyopia. However, further genetic-based studies are suggested in this regard.

Since the participants in this study were 7 years of age, they have a much lower chance of successful treatment compared to those aged 4–6 years, and they are at risk of permanent vision impairment.

As mentioned earlier, there was a considerable difference in the prevalence of amblyopia among different cities, which we believe is due to ethnic, genetic, and economic differences among these cities. Since all examinations were performed by one person in all cities and the same devices were used, this difference cannot be attributed to the methodology of the study.

In the present study, we found no significant intergender difference in the prevalence of amblyopia. Similarly, Megbelayin[18], Brown et al.[28], Fu et al.[10], Pai et al.[12], and Yekta et al.[21] have stated that sex has no significant effect on the prevalence of amblyopia. Nonetheless, Caca et al.[25] found a higher prevalence of amblyopia among girls. Overall, sex does not seem to be an important risk factor for amblyopia.

More than 60% of cases in this study had unilateral amblyopia. A similar observation was made by Fu et al.[10] (66.7%), Chia et al.[8] (69.7%), and Sapkota et al.[29] (71%). Some adult studies also point to a high prevalence of unilateral amblyopia.[14] Unilateral amblyopia is predominant because the most common causes of amblyopia are anisometropia and strabismus. In anisometropia, an interocular difference in refractive errors leads the worse eye towards amblyopia. In strabismus, especially esotropia,

unilateral amblyopia is expected due to suppression of one eye.

Among the causes of amblyopia, strabismus was more common than anisometropia in this study; 61.9% of cases were strabismic, 27.0% were anisometropic, and 9.5% were isometropic. This pattern is slightly different from many previous reports that found anisometropia and refractive errors to be more common than strabismus.[8–14] According to a report by Lithander,[17] strabismus was more common than anisometropia in Oman as well. Reviewing the causes of amblyopia reveals some interesting points. In Eastern Asian countries,[8,10,13,30,31] amblyopia is mostly due to refractive errors, while in countries such as the United States, England, and Australia, amblyopia is mostly of the strabismic type.[32] Such differences show the role of screening programs and their effect on the predominant type of amblyopia in children. In western countries, screening programs have a longer history compared to Middle Eastern and Asian countries.[33] The higher prevalence of refractive errors in East Asian countries must be noted as well. Overall, explaining these findings can be quite difficult, and they may be indicative of a high prevalence of strabismus in Iranian children. In our belief, since screening programs have been conducted in Iran for about 15 years,[23] anisometropic cases of amblyopia have been identified and simply treated with correction, while strabismic cases, which need more sophisticated treatment and surgery, have worsened. This could explain the lower prevalence of anisometropic amblyopia.

In the results, we showed a larger shift towards hyperopia and astigmatism among amblyopic children. This is in agreement with previous reports.[21,22] Today, these two types of refractive error are commonly suggested as risk factors for amblyopia. The main reason is the failure to form a clear retinal image in hyperopia and astigmatism. Therefore, hyperopic and astigmatic children need to be identified and treated with proper correction from childhood.

CONCLUSION

Results of this study show the prevalence of amblyopia throughout Iran, and it was demonstrated that the prevalence of amblyopia is not low in Iran. Amblyopia is more common in hyperopic and astigmatic individuals and therefore it is important to pay more attention to this refractive error during childhood. Screening programs should be monitored more seriously to ensure strabismic cases are identified. Contrary to some previous reports, strabismus is the most common cause of amblyopia in Iran, and strabismic cases need to be treated before the age of 5 years.

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DECLARATION OF INTEREST

The authors report no conflicts of interest.

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